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VESICULAR STOMATITIS OF HORSES AND CATTLE.

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HISTORY AND CHARACTERISTICS.

Vesicular stomatitis is known in Europe and South Africa, and has been observed occasionally in sporadic form in the United States, but without attracting any particular attention. During the early fall of 1916, however, it became very extensive in certain sections of this country, being especially prevalent in Nebraska, South Dakota, Colorado, and Wyoming. It was first reported among the horses and mules at remount stations in the Central West, where large numbers of animals had been collected prior to shipment to Europe for use in the French and British Armies. Here the disease found ideal conditions for its spread among thousands of these animals closely quartered in barns and pens. From these remount stations in the Central West the disease became distributed by following the channels of trade from the westward markets eastward as far as the Atlantic coast. The affection did not stop even there, as several shipments were made abroad while the horses were in the incubative stage of the disease, and infected American horses were found shortly after arrival in France.

Strange as it may seem, the first information that this country was experiencing an outbreak of vesicular stomatitis was reported in an article by the French veterinarian Jacoulet, which appeared in the Recueil de Médecine Vétérinaire, December 30, 1915. Owing to the difficulties attending the delivery of these European periodicals since the beginning of the war this copy was not received until several

months later. Jacoulet referred to the erosive stomatitis of indeterminate nature affecting horses coming from America for the French Army. He indicated that some of the veterinarians coming to the army depot were acquainted with this disease, calling it stomatitis of horses and attributing it to the fact that the new horses frequently licked the freshly whitewashed walls near them. The question of etiology was at once referred to the Pasteur Institute, but at that time attempts to carry the disease from horse to horse proved unsuccessful. The opinion was thereupon advanced that defective feed probably of a mycotic nature was responsible, especially since moldiness was quite extensive in American baled hay brought over with the horses.

In the issue of the above-named French journal dated February 29, 1916, Vigel records having observed the disease in question in a large number of American animals. On the basis of his observations he believed that the cause of vesicular stomatitis is a contagion and should not be looked for in the poor quality of hay, as the disease spread to French horses on the surrounding farms and these animals had never eaten American hay. At least one cow became similarly affected. Three bacteriologists of the French Army took samples of blood and vesicular fluid from infected horses, but their results were likewise negative. However, Vigel proved quite clearly that the disease is contagious and transmissible through direct inoculation. More recently, May 15, 1917, Panisset reports in the Revue Générale de Médecine Vétérinaire that vesicular stomatitis had gained considerable ground during the previous few months, but not sufficient to cause any alarm. Particularly those depots that received horses coming from the first infected remount stations have paid heavy tribute to the affection. Although known and described in France before the present war, it had been observed only occasionally and its present frequency there is considered by Panisset to be due to importations of infected American horses for military purposes.

Notwithstanding that the disease primarily affects horses and mules, it may spread to cattle under appropriate conditions, but thus far it has not been observed under natural conditions among hogs and sheep. Evidently the necessary conditions for its spread from horses to cattle obtained in Nebraska, as a shipment of cattle from that locality to the Kansas City Stock Yards in the fall of 1916 was found infected. Much excitement was occasioned thereby, as the disease was quite suggestive of foot-and-mouth disease. However, a series of careful experiments was at once begun, from which the true nature of the disease was ascertained and the diagnosis of vesicular stomatitis made.

Among other more important forms of stomatitis may be mentioned mycotic stomatitis of cattle, which results from eating feed

containing irritating fungi; necrotic stomatitis, especially affecting calves and pigs, which is caused by infection with the necrosis bacillus; stomatitis contagiosa, or foot-and-mouth disease, which is one of the most highly infectious diseases of animals and caused by a filterable virus; and pustular stomatitis, which is less contagious in character than the former and confined solely to the equine.

Concerning vesicular stomatitis, the name not only indicates the location of the lesions in the mouth, but also suggests that the vesicles or blisters are characteristic features, being observed at the beginning of the disease. Other names which have been applied to this affection are sporadic aphthæ, stomatitis vesiculosa, stomatitis aphthosa, erosive stomatitis, sore mouth, "blue tongue," and pseudo foot-and-mouth disease.

ETIOLOGY.

The literature upon the subject of vesicular stomatitis fails to incriminate definitely any specific organism as the cause of this contagion. Repeated cultural studies of fresh vesicular fluid drawn under aseptic precautions from experimentally infected horses and from field cases have resulted in the isolation of a variety of microorganisms including micrococci, several short rod-shaped bacilli, one of which takes the bipolar stain, a large Gram-negative spore-bearing rod, and a fungus. Horses and calves were subjected to inoculations with cultures of these several organisms, both intravenously and by scarification of the epithelial covering of the tongue and inner surface of the lips, but in no instance was the inoculation successful. An inoculation test of a small micrococcus isolated and cultivated under strict anaerobic environment proved it to be innocuous to horses and calves. Finally, fresh vesicular fluid passed through a Berkefeld (N) filter was completely divested of all infectious qualities as determined by inoculation tests of the filtrate in six different experiments.

Microscopic examination of fresh vesicular fluid by dark-field illumination revealed the presence of micrococci and in addition small bodies with refractive coverings which were very similar in appearance to the spores of a fungus isolated on egg medium from a sample taken from a case of vesicular stomatitis.

A bacteriological report of the work done by Dr. George Mathers, of the University of Chicago, on the etiology of this disease was read at the annual meeting of the United States Live Stock Sanitary Association,[1] but the evidence presented in favor of the bacillus described was far from conclusive. Through the courtesy of Dr. James Gregg, of the British remount station at Newport News, Va., several cultures of a microorganism which he had isolated from a

[1] Report of Twentieth Annual Meeting of the United States Live Stock Sanitary Association, December, 1916, p. 33.

case of vesicular stomatitis in a mule and with which suspicious symptoms of the disease were induced in other mules,[1] were obtained for study. With this organism, which proved to be a facultative anaerobe and very slow to develop on any medium, we were unable to infect horses or calves by direct inoculation of large amounts of the culture. Moreover, the employment of this organism, as well as several other different organisms, as an antigen in the complement-fixation test failed to give positive results with sera from either immune horses or immune cattle.

SYMPTOMS AND LESIONS.

The first phenomenon of vesicular stomatitis consists in the formation of reddened patches on the buccal mucosa, especially of the tongue. These are quickly succeeded by vesicles or blisters of grayish-red color only slightly elevated and of various sizes from a dime to a silver dollar, filled with clear or yellowish serous fluid. These blisters may be isolated, but frequently they coalesce to form a large vesicle. They usually rupture in a very short time, which accounts for their not being recognized at times even in the early stages of the disease. The rupture of the vesicles results in exposing the raw underlying surfaces, which appear as reddened erosions with the grayish-white fragments of the torn mucous membrane of the preexisting vesicles still attached to the irregular borders like a fringe. These erosions may become confluent, varying from the size of a dime to that of the palm of the hand, and may even involve practically the entire upper surface of the tongue in horses. Healing varies, but usually occurs quite rapidly in from 8 to 15 days in uncomplicated cases.

While these lesions in horses are principally confined to the upper surface of the tongue, they may involve the inner surface of the lips, the angles of the mouth, and the gums. In cattle, on the other hand, the tongue does not appear to be so extensively affected, and lesions may also occur on the hard palate, lips, and gums, sometimes extending to the muzzle and around the nostrils. Often the lips of the horse are swollen and itchy, which causes the animal to rub the muzzle against any near-by object. In a very few cases fresh cows have shown similar lesions on the teats when their infected calves had been sucking them, but no feet lesions have been observed in these cases.

Immediately before or simultaneously with the appearance of the vesicles there is present a moderate rise of temperature, which rapidly subsides. A more or less profuse flow of saliva follows, which dribbles from the lips and consists of a thin, stringy, or frothy fluid. Not infrequently the presence of salivation is the first indica-

[1] American Journal of Veterinary Medicine, vol. 12, No. 4, April, 1917, p. 221.

tion that the animal is sick. Owing to the painful condition of the mouth at this stage, there is loss of appetite or at least inability to eat, and in horses gritting of the teeth is quite frequent, while in cattle "smacking" noises are heard as in foot-and-mouth disease. This sensitiveness as a rule remains for several days, after which healing commences, and it is remarkable to observe how quickly the sick animals will begin to eat even while their tongues are still eroded. Although eating well, they do not regain their original thrifty appearance for some time longer. In dairy cows in addition to shrinkage in flesh there is a noticeable reduction in the normal flow of milk for a few days.

So far as our observations are concerned, the period of incubation of vesicular stomatitis has varied from 36 hours to 9 days, but the greatest number of cases have occurred in from 2 to 5 days after exposure.

No losses have been reported from uncomplicated cases of this disease in either horses, mules, or cattle. A certain proportion of horses and mules having vesicular stomatitis also became infected with either influenza or contagious pneumonia, or perhaps both, and some deaths have occurred among such animals.

CONTAGIOUSNESS.

That the malady is contagious has been definitely shown by the transmission of the disease from sick to healthy animals by inoculation. The degree of contagiousness, however, varies between wide limits. In fact, certain writers have claimed that it is not contagious, because they fail to reproduce the disease after experimenting with only one healthy animal. Our experience with this disease shows that frequently one or even more of the inoculated animals in an experiment will fail to develop the infection, as in several instances we have produced the disease in only two out of three, or two out of four, or, again, three out of nine of the experimental animals; so that it is necessary to use more than one animal if accurate information is to be obtained. This point is strongly brought out by the opposite conclusions reached by the two French investigators, Jacoulet and Vigel, who recently found the disease in American horses shipped to France. The former believes the disease is benign, nontransmissible, and of alimentary origin, while the latter readily transmitted the disease to other horses and convinced himself of its contagiousness.

Experiments have proved that the disease is most virulent at the time the blisters rupture or shortly thereafter, but when the lesions are five or six days old the virus of the disease has practically disappeared. This may account for the greatly differing results investigators have had in their attempts to transfer the disease artificially. These facts show the necessity of using several experi-

ment animals for inoculation, and also of injecting the infectious material as soon as possible after the blisters have formed.

The virus is evidently of short life, and is transmitted only by close contact. Probably the infected environment remains dangerous longer than the affected animals. At the Bureau of Animal Industry Experiment Station one field was set aside for animals which had recovered from attacks of vesicular stomatitis. Horses and cattle were placed in this field 3 weeks after they first showed symptoms of the disease. Healthy susceptible cattle were kept in this field as a check on the possible spread of the disease, but in no instance did they become infected. Likewise, susceptible animals turned into a stable which 3 weeks previously in one instance, and 16 days previously in another instance, had harbored active cases of vesicular stomatitis, remained well. Several instances have been reported in which a line fence or a board fence in a double corral has been sufficient to prevent transmission of the disease from the infected animals on one side to the healthy animals on the other.

Investigations indicate that the disease is very seldom communicated by owners or caretakers of affected animals visiting other farms. As a rule the disease appears to spread by direct contact with recently affected animals, or by recently infected feed troughs, water troughs, bridles, or pails. Inoculation experiments on such laboratory animals as rabbits, guinea pigs, rats, and mice have resulted negatively. The disease manifests itself in susceptible animals more rapidly after the application of infectious material to scarified areas in the mouth than through intravenous injection, although positive results have been obtained also by the latter method.

Contrary to experiences in the field, we were able in several test inoculations to transmit infection to the feet of cattle in a small proportion of cases, and likewise this virulent material also produced lesions in from five to nine days in the feet of one hog, in the mouth of another, and on the snout of the third. While these cases were the exception and not the rule, they should be recorded for their scientific interest. In this connection it should be stated also that a number of hogs in immediate contact with these animals but without receiving any artificial inoculation remained normal in all cases, while a number of cattle similarly exposed contracted lesions which were confined solely to the mouth. Infectious material expelled from the mouths of attacked animals and kept moist by placing it in a sealed test tube, protected against exposure to light, retained its virulence for three weeks in one instance. Such material after being dried or preserved in normal salt solution lost its virulence in a much shorter period of time.

Very little work appears to have been done on the question of immunity in this disease. A number of horses and cattle which were

typically affected at the bureau experiment station failed to contract the disease when inoculated with the virus three months later, although the control animals became infected promptly. It may be stated that in these cases immunity had persisted for at least three months. Further tests regarding its duration could not be made, because the required infectious material was not obtainable owing to the disease having disappeared. Injections of blood serum from immune animals so far as tested induced no resistance to the disease.

Whether the milk of affected cattle is or is not infectious for people has not been recorded, but such milk has been fed experimentally to hogs without producing any ill effects.

DIFFERENTIAL DIAGNOSIS.

While the disease has not the great economic importance of foot-and-mouth disease, it nevertheless is contagious and causes considerable alarm owing to its close resemblance to the dreaded European disease. Furthermore, as most writers state, this infection in cattle may be readily confounded with foot-and-mouth disease, and experience has shown that a prompt and exact differentiation is accompanied with numerous difficulties. The real difficulties surrounding the diagnosis are best appreciated by those who have faced them with the consciousness that their pronouncement if mistaken would lead on one hand to unnecessary and serious economic disturbances and on the other hand to the spread of one of the most dreaded and easily communicated among animal plagues. Vesicular stomatitis therefore will prove a menace whenever and wherever it may reappear. For these reasons it is strongly urged that local quarantines to prevent its spread be imposed by State live-stock officials in whose territory the disease may be found. All owners and handlers of horses, mules, and cattle, particularly liverymen, managers of stockyards, and stockmen, should be directed to separate sick from well animals, clean and disinfect contaminated premises, and have all infected animals appropriately treated.

The opinion that the malady is not foot-and-mouth disease is based on the fact that persistent observation of sick animals has failed to reveal certain typical symptoms which would be expected in an outbreak of foot-and-mouth disease. The drooling, vesicles, and erosions are similar in appearance to those produced by foot-and-mouth disease, but in none of the animals examined in the field has there been found any soreness of the feet, which is a common symptom of foot-and-mouth disease. Moreover, many horses have this particular ailment, but horses have not been observed to contract foot-and-mouth disease in any of the previous foot-and-mouth outbreaks in the United States. Hundreds of hogs exposed to the disease

and in association with the sick animals in pastures have shown no signs of the malady, which is regarded as significant, because in the last outbreak of foot-and-mouth disease hogs were as susceptible to that disease as were cattle. Exposed sheep also failed to show vesicular stomatitis, yet these cloven-footed animals are susceptible to foot-and-mouth infection. In a number of cases of vesicular stomatitis the lesions appeared to be continuous or progressive, and not explosive, as in foot-and-mouth disease. In these instances secondary lesions were apparent on a number of consecutive days in the mouths of both horses and cattle, and vesicles were observed on the bases of tongues whose free portions were almost denuded of mucous membrane as a result of the rupture of similar vesicles six or seven days before.

Complications are extremely rare in vesicular stomatitis, and neither mammitis nor chronic diseases of the hoof have been observed following it. Sucking calves are seldom affected with the disease, and rarely in other than a mild form, while an attack of foot-and-mouth disease in calves is always serious and not infrequently fatal. The vesicles in foot-and-mouth disease as a rule are larger than in vesicular stomatitis, and are more tightly filled with serous fluid. Furthermore, instead of increasing in virulence by passage through a series of calves, as foot-and-mouth disease has always done in our previous experiments, vesicular stomatitis became greatly reduced in pathogenesis and required a constantly increasing period of incubation before manifesting lesions of the disease. Although numerous filtrate experiments have been conducted, in no case has the disease been reproduced in this manner, which is also unlike our experiments with foot-and-mouth disease.

The percentage of animals infected in each of the herds of cattle, and the history of exposure without transmission of the disease except by immediate contact, would indicate that this ailment is not the highly contagious foot-and-mouth disease which, once it is introduced into a herd, quickly affects practically 100 per cent of the cattle and hogs on all the farms to which the virus may be carried by intermediate agencies.

The result of this study of vesicular stomatitis suggests the necessity of inoculating horses with suspected material in any future outbreak of disease bearing a resemblance to foot-and-mouth disease.

Finally, it must be apparent that in vesicular stomatitis we have a disease more closely resembling foot-and-mouth disease than either mycotic or necrotic stomatitis, and that Hutyra and Marek are correct in their opinion that a reliable differential diagnosis can be made only after inoculation experiments and careful observation lasting a number of days.

TONGUE OF HORSE AFFECTED WITH VESICULAR STOMATITIS, SHOWING LESIONS IN THE MIDDLE AND ON THE TIP FROM WHICH THE MUCOUS MEMBRANE HAS BEEN REMOVED.

In mycotic stomatitis portions of the lining membrane of the mouth become inflamed, and in a few days it changes to a croupous membrane which peels off leaving a raw surface, while the thin skin between the toes may also be inflamed. Swelling of the feet and stiffness of the animal are frequently evident in mycotic stomatitis. The previous history of the case, the absence of its spread to horses exposed to the infection, and the complete negative results obtained by the inoculation of calves, distinguish between this disease and vesicular stomatitis. Lastly, mycotic stomatitis occurs in only from 10 to 15 per cent of the cattle in a herd, usually late in the summer or early in the fall after a dry spell, and it does not run a regular course.

Necrotic stomatitis may be distinguished from vesicular stomatitis by the fact that while it affects cattle and especially calves, it may also involve pigs and sheep, but its spread among the animals of a herd shows a much lower degree of infectiousness than vesicular stomatitis. The characteristic lesion of the latter is the appearance of blisters containing a serous fluid on the mucous membrane of the mouths of the affected animals. In necrotic stomatitis blisters are never formed, destruction of the tissues occurring from the beginning and being followed by the formation of yellowish, cheesy patches principally found involving the lining membrane of the mouth, especially the tongue and cheeks. The cause is the *Bacillus necrophorus*.

In horses vesicular stomatitis must be differentiated from contagious pustular stomatitis, and this is not difficult. In the latter disease there are no simple erosions, but instead there are raised nodules on the mucous membrane of the mouth. These nodules suppurate and liquefy in the center, causing the conical surfaces to slough, resulting in the formation of pustules or ulcers, from which the name of the disease is derived. The location of the nodules and pustules is chiefly on the lips, gums, inside of the cheek, and on the tip and sides of the tongue. While the disease may be transmitted artificially to cattle, sheep, and hogs, it occurs under natural conditions only among equines.

TREATMENT.

The treatment of vesicular stomatitis consists in first removing the affected from the healthy animals and isolating the former until fully recovered. Such isolation together with the adoption of rigid sanitary precautions greatly reduces the prevalence of the disease. If the animals are gentle enough to be handled, one-half tablespoonful of borax should be placed on the tongue twice daily, or the mouth syringed several times a day with a 1 per cent solution of

permanganate of potassium; otherwise 2 heaping tablespoonfuls of borax or 1 tablespoonful of potassium chlorate should be dissolved in a bucket of water and the affected animals allowed to drink or rinse their mouths with this medicated water at their pleasure. Hay should not be fed for the first few days, but instead bran or other soft feed should be given. If the animals are treated in this manner and carefully fed, the disease should rapidly disappear.

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